Modeling the potential impacts of two BREXIT scenarios on the Danish agricultural sectors

Yu, Wusheng; Elleby, Christian; Lind, Kim Martin Hjorth; Thomsen, Maria Nygård

Publication date:
2017

Document version
Publisher's PDF, also known as Version of record

DEPARTMENT OF FOOD AND RESOURCE ECONOMICS
UNIVERSITY OF COPENHAGEN

IFRO Report

Modeling the potential impacts of two BREXIT scenarios on the Danish agricultural sectors

Wusheng Yu
Christian Elleby
Kim Martin Lind
Maria Nygård Thomsen

260

IFRO Report 260

Modeling the potential impacts of two BREXIT scenarios on the Danish agricultural sectors

Authors: Wusheng Yu, Christian Elleby, Kim Martin Lind, Maria Nygård Thomsen

Scientific quality control: Per Svejstrup Hansen

Published June 2017

ISBN: 978-87-92591-81-4

This report is the result of a project commissioned by the Ministry of Environment and Food of Denmark (MFVM).
The authors are responsible for the research findings contained in this report.

IFRO Report is a continuation of the series FOI Report, published by the former Institute of Food and Resource Economics. The report series can be found here:
http://ifro.ku.dk/publikationer/ifro_serier/rapporter/

Find other IFRO Commissioned Work (mostly in Danish) here:
http://ifro.ku.dk/publikationer/ifro_serier/udredninger/

Department of Food and Resource Economics
University of Copenhagen
Rolighedsvej 25
DK 1958 Frederiksberg
www.ifro.ku.dk/english

Executive summary

This study provides a quantitative analysis of the potential medium-run impacts of two Brexit scenarios on the Danish food and agricultural sectors. In the WTO scenario, the UK and EU are assumed to treat each other on WTO MFN terms, implying rising bilateral tariffs to the MFN levels of the EU and also rising non-tariff barriers; whereas in the FTA scenario, a normal free trade area between the two sides are assumed, implying zero tariff but still rising NTBs. The UK is further assumed to exit preferential trade agreements negotiated by the EU with third countries in both scenarios, implying rising trade costs between the UK and these third countries.

The expected medium-run impacts of the two scenarios are evaluated in a common baseline in a computable general equilibrium model. The baseline is constructed by projecting the world economy to 2021, a year when the Brexit scenarios are assumed to be in effect. In the baseline, current macroeconomic projections towards 2021 are targeted while current trade policies including the membership of the UK in the EU common market are maintained. Additionally, a few important preferential trade agreements currently negotiated or considered by the EU are also assumed in the baseline. Simulation results suggest that bilateral exports from Denmark to the UK would shrink significantly under the WTO scenario, particularly for key export products such as processed foods, pork products, and dairy. Total Danish food and agricultural exports to the UK would fall by as much as 79 percent under the WTO scenario and by about 48 percent under the FTA scenario. In addition to the expected rise in tariff barriers, the assumed large increases in non-tariff barriers in the two scenarios are also key driver behind these results. However, reductions of total Danish agri-food exports would be quite limited in both scenarios, due to the possibilities for Danish exports to be redirected within the EU and to countries that are partners to the various preferential trade agreements of the EU and due to the fact that exports to UK are only a fraction of total Danish exports. While total Danish exports are expected to drop slightly, prices of Danish exports would also be dampened but only to even smaller extent. Reductions in domestic production of key export products would be quite small as well. For processed foods, pork, and dairy, domestic outputs would be 2.5, 2.2, and 1.1 percent lower than the baseline levels in the WTO scenario. In connections with changes in domestic outputs, Danish processed food, pork and dairy sectors' labor employment would shrink by 1.1-2.6 percent under the WTO scenario and 0.2-1.5 percent under the FTA scenario.

At the macro level, nominal GDP for both Denmark and the UK are expected to decrease relative to the baseline; however, losses to Danish GDP are expected to be much smaller at about 0.64 percent

under the WTO scenario and at 0.44 under the FTA scenario, as compared to the 4.8 and 3.4 percent losses for the UK under the two scenarios respectively. Expected decreases in real GDP in the two countries are much smaller in both scenarios. These relative differences in GDP losses are indications of the asymmetric nature of the trade policy changes associated with the assumed Brexit scenarios as the extent of rising trade barriers facing UK exports are far greater than those facing Danish exports. Moreover, the EU single market and preferential accesses to the market of EU's FTA partner countries provide ample flexibilities to redirect trade flows for remaining EU member states such as Denmark.

Based on these simulation results, this study suggests that the overall negative results arising from rising trade costs due to Brexit are more pronounced for the UK. For Denmark, while bilateral exports for key exportable sectors may be hit hard, overall Danish exports would be impacted relatively little. Between the two scenarios considered, an FTA with the UK would enable both sides to avoid larger losses to trade flows, domestic outputs, and employment. To create more flexibilities to fully compensate the anticipated lost trade flows to the UK market, one option for the EU including Denmark is to pursue further trade liberalization at multilateral and bilateral levels.

List of abbreviations

AVE	Ad Valorem Equivalent
CAP	Common Agricultural Policy
CGE Model	Computable General Equilibrium Model
CIF	Cost, Insurance, and Freight
EU	European Union
GTAP	Global Trade Analysis Project
GDP	Gross Domestic Products
FTA	Free Trade Area
MFN	Most Favored Nation
NQT Model	New Quantitative Trade Model
NTB	Non-Tariff Barrier
PTA	Preferential Trade Agreement
ROO	Rules of Origin
WTO	World Trade Organization

1 Introduction

The economic consequences of Brexit are a contested issue that continues to spur debate. Apart from the inherent uncertainty generated by such a big change in international relations, the details of the divorce settlement between the UK and the EU have important implications for the post-Brexit trading relations and economic conditions for both the UK and the EU. Furthermore, the UK's future trading agreements with third countries can impact the UK, the EU as well as individual EU member countries differently, depending upon e.g. specific stipulations for various commodities.

In this report we evaluate the impacts of Brexit[1]. In light of the uncertainty regarding the future relationship between the UK and the EU27, we limit our analytical attention to two possibilities: a future Free Trade Agreement (FTA) between EU27 and the UK ("optimistic" scenario) and a scenario where the UK and EU27 trade with each other on WTO's Most Favored Nation (MFN) terms ("pessimistic" scenario). Each of these scenarios is evaluated against a benchmark or "baseline" where the UK is assumed to remain in the European Union.

Our modeling approach is fairly standard in that we use a global Computable General Equilibrium (CGE) model[2] to assess the impacts of Brexit. In our "optimistic" scenario where the UK enters into an FTA with EU27 we find a nominal GDP impact of -0.4 percent for Denmark and -3.4 percent for the UK. In the "pessimistic" scenario, where the UK and EU27 trade on MFN (rather than preferential) terms, the Danish and UK GDP impacts become -0.6 and -4.8 percent, respectively. Changes in real GDP in the two Brexit scenarios are smaller than changes in nominal GDP in both countries, but the relative magnitudes of real GDP changes between Denmark and UK remain the same. Our results therefore indicate that the Danish economy will be affected by Brexit but the impact on the UK economy is one order of magnitude higher. Moreover, as expected, the WTO MFN scenario leads to more negative impacts than the FTA scenario for both the UK and for Denmark. These findings are also broadly in line with the literature. Emerson et al. (2017), for example, report

[1] This report is the result of a project commissioned by the Ministry of Environment and Food of Denmark (MFVM) on the potential impact of BREXIT on Danish agriculture sectors. Per Svejstrup Hansen from the Department of Food and Resource Economics and the University of Copenhagen has acted as internal reviewer for this report and provided useful comments, for which the authors are grateful.

[2] We use the Global Trade Analysis Project (GTAP) model.

an average estimated UK GDP impact of -1.3 and -4.2 across all the "optimistic" and "pessimistic" scenarios in the various published Brexit studies listed in Table 1 below.[3]

In this report the "optimistic" scenarios are those which lead to a small increase in trade barriers whereas "pessimistic" scenarios are those which lead to larger trade costs increases.[4] For example, the "optimistic" scenario in Dhingra et al. (2016) refers to a situation where the UK remains in the European single market and has a Free Trade Agreement (FTA) with EU27 (similar to Norway). In their "pessimistic" scenario, on the other hand, the authors assume that the UK and EU27 cannot agree on an FTA and the two subsequently trade on MFN terms. This is also how the "pessimistic" scenario is defined in the other studies listed in Table 1. The "optimistic" scenarios in the other studies in Table 1 all refer to an FTA between the UK and EU27 and, in some cases, the UK staying in the single market.

Table 1. Estimated long term (2030) GDP impacts from BREXIT

Study	**Scenario**	**UK impact**	**EU27 impact**
		(% change in GDP relative to baseline)	
Kierzenkowski et al. (2016)	Optimistic	-2.7	-
	Central	-5.1	-
	Pessimistic	-7.7	-0.8
Dhingra et al. (2016)	Optimistic	-1.3	-0.1
	Pessimistic	-2.6	-0.3
Aichele and Felbermayr (2015)	Optimistic	-0.6	-0.1
	Pessimistic	-2.3	-0.3
Rojas-Romagosa (2016)	Optimistic	-3.4	-0.6
	Pessimistic	-4.1	-0.8
Booth et al. (2015)	Optimistic	+1.5	-
	Mid-range 1	+0.6	-
	Mid-range 2	-0.8	-
	Pessimistic	-2.2	-0.3
Treasury (2016)	Optimistic	-3.8	-
	Central	-6.2	-
	Pessimistic	-7.5	-
Average	**Optimistic**	**-1.3**	**-0.1**

[3] Differences in methods, model assumptions, scenarios and base years are the main reasons that results differ across studies. For instance, as will be discussed below, the current study assumes a baseline of 2021 whereas studies surveyed in Table 1 refer to a baseline of 2030.

[4] "Optimistic" and "pessimistic" scenarios are also sometimes referred to as a "soft" or a "hard" Brexit, respectively.

	Pessimistic	**-4.2**	**-0.5**

Note: The EU27 impact in Kierzenkowski et al. (2016) refers to the medium term defined as year 2023. Source: Adapted from Emerson et al. (2017).

In order to implement these scenarios in a quantitative model, one has to make specific assumptions about the changes in tariff and non-tariff barriers (NTBs) and the speed at which trade costs change following Brexit. Dhingra et al. (2016), for example, assume that NTBs increase in both scenarios but the increase in NTB trade costs in the "optimistic" scenario is only one third of the increase in the "pessimistic" scenario. Moreover, in the "optimistic" scenario it is assumed that intra EU27 trade costs fall 20 percent faster than in the rest of the world, while in the "pessimistic" scenario they fall 40 percent faster, as had been the case historically (see Méjean and Schwellnus, 2009). Although it is not always stated clearly, any quantitative trade analysis necessarily involves a large number of such choices and compromises. We will elaborate on the details of how we implement our own scenarios as well as how we define the baseline in section 3.

As mentioned above, the Brexit impacts that we calculate in this report is based on a CGE model. Two of the studies listed in

Table 1, namely Booth et al. (2015) and Rojas-Romagosa (2016), are also based on CGE model simulations. The main advantage of a CGE model in general and the GTAP model in particular, is its level of details. A CGE model is a stylized internally consistent representation of an entire economy, made up of a number of sectors. This means that a shock to the price of a good in a given sector (e.g. through changes to a tariff), for example, not only affects input demand and output supply in that specific sector, it has ripple effects on all sectors of the economy as the economy moves towards a new equilibrium. GTAP simulations thus provide very comprehensive and detailed impacts of policy changes, including changes to global production patterns, trade flows, employment, wages etc., at a sectoral as well as the aggregate level. The complexity of a CGE model is probably also its main potential weakness. For example, the large number of behavioral parameters in the model means that it is very difficult to evaluate how robust the results are to changes in assumption about relationships between the variables in the model. Moreover, these parameter values are often not founded on rigorous up-to-date empirical analysis as the exercises to calibrate models to new parameters are often quite time-consuming. However, recent advances in parameter estimation and validations in CGE models such as GTAP have led to increased confidence in modeling results and resulted in these models' popularities in trade policy analysis.

There are two main alternatives to CGE modelling of trade policy impacts. These are both based on an econometric model where (some of the) key parameters are estimated prior to any impact calculations. The first alternative is a micro based approach knows as the gravity model, which quantifies the determinants of bilateral trade flows. These determinants can be grouped into three main categories namely measures of economic size, geographic distance, and other factors affecting trade costs such as common language, FTAs, etc. Estimates from a gravity model can be used to predict the trade impact of a change in trade policy but they do not reflect welfare impacts or changes in macro variable such as GDP or employment. Gravity estimates can, however, serve as inputs into so called New Quantitative Trade (NQT) models. A NQT model is also a type of general equilibrium model but with a much simpler structure than a CGE model. These can be used to calculate sectoral and aggregate welfare impacts but not impacts on employment, wages and other economic variables that are often of interest for policy makers. A main benefit of NQT models over CGE models is that they are less complex, easier to comprehend and the data requirements are much less demanding. Another advantage is that the key parameters are estimated prior to the impact calculations so there is a stronger correspondence between the data and the results than in a CGE model. Among the studies listed in Table 1, Dhingra et al. (2016) and Aichele and Felbermayr (2015) are based on a NQT model.

The second alternative to CGE models is a global macroeconometric model á la NiGEM.[5] Unlike CGE and gravity models that are both usually static, macroeconometric models are dynamic and agents are forward looking. Key macroeconomic variables such as GDP, import and export are determined within the model and can easily be forecasted. CGE models, on the other hand, allow for a much more detailed analysis of the sectoral impacts and for a more thorough analysis of various policy options. As for the NQT models, parameters are estimated prior to impact evaluation step but a macroeconometric model allows for a forecast of the entire time path towards any given future date, including the uncertainty involved, rather than a comparative static analysis of two situations where the time dimension does not feature explicitly. The studies by Kierzenkowski et al. (2016) and Treasury (2016) are both (partly) based on the NiGEM model.

Unlike the studies mentioned above, our focus in this report is on the agri-food sector impacts, namely the agri-food sector in Denmark. Another novelty is that we analyze carefully the effects related to some of EU's Preferential Trade Agreements (PTAs) with third countries. For example, the EU has a PTA with Korea, Norway, Turkey and many other countries. Moreover, EU has reached an

[5] NiGEM stands for (the) National Institute Global Econometric Model.

agreement with Canada (CETA) and there are ongoing or prospective negotiations with Japan, Brazil (as part of the negotiations with MERCOSUR), USA, Australia and New Zealand among others.[6] We evaluate how the impact of Brexit on the Danish economy in general and the agri-food sector in particular, depends on the successful completion of these trade agreements. We assume that the UK will not be part of any of these PTAs following Brexit.

At the sectoral level, our results suggest that the WTO scenario will lead to quite dramatic reductions in bilateral exports of key agri-food products from Denmark to the UK, such as processed foods, pork products and dairy; however, by taking into account the flexibilities to redirect trade flows within the EU27 and to third countries, the overall Danish agri-food exports would fall very little.

The rest of the paper is organized as follows. Section 2 presents some basic facts on bilateral trade patterns between Denmark and the UK and provides more details regarding the two Brexit scenarios considered in the study. Section 3 is devoted to a discussion of methodologies, data and the construction and implementation of the baseline and scenarios. Section 4 presents the results and the analysis of the results. The final section concludes with the main findings and offers some qualifications of such findings.

2 Trade patterns and post-Brexit options

2.1 Bilateral trade patterns between Denmark and the UK

The UK is an important export destination for Danish agricultural and food products, particularly for the aggregated product categories of processed foods, pork and poultry (which is mainly pork based products in the case of Danish exports), and milk and dairy products. During the period of 2011-2013, Danish exports of processed foods, pork and poultry, and milk and dairy products were respectively in the range of DKK3.9 to 4.5 billion, 4.9-5.7 billion, and 1.3 to 1.8 billion (See Appendix Table 1 for details; data sourced from the GTAP database), all representing significant shares of total Danish exports in those categories. In total, Denmark's exports of agri-food products to the UK amounted to more than DKK 12 billion per year during the 2011-2013 period. In all, Danish exports of agricultural and food products to the UK in this period were more than 20 percent of total Danish merchandise

[6] Negotiations with Australia and New Zealand are not formally launched yet, although the scoping exercises have been concluded. We therefore exclude the prospect FTAs with Australia and New Zealand from our baseline. Likewise, future FTAs with the USA and Turkey (agriculture sectors) are not considered in the baseline, either. Current and future FTAs that are assumed in the baseline are discussed in Section 3 and are listed in Tables 2 and 3.

exports to the UK.[7] In contrast, total agricultural and food imports from the UK to Denmark were much smaller, ranging from about DKK 2.6 billion in 2011 to 3.1 billion to 2013. This indicates a rather large trade surplus in agricultural and food products for Denmark and points out to the potential negative impacts of Brexit on the key agricultural and food sectors.

2.2 Post-Brexit options

When the UK leaves the European Union it needs to renegotiate its trade relationships with the remaining members of the EU (EU27 hereafter) as well as with third countries with which the EU has existing preferential trade agreements (PTAs) or is currently negotiating PTAs. Renegotiated trade relationships may imply changes in import tariffs as well as regulation influencing trade flows i.e. regulations acting as Non-Tariff Barriers (NTBs).

Options for EU27-UK bilateral trade arrangements

The literature on Brexit has so far revolved around five scenarios or models for the future EU27-UK relationship, with different implications on trade costs and consequently trade flows (PwC, 2016, Dhingra et al., 2016, Irwin, 2015, van Berkum et al., 2016, Kierzenkowski et al., 2016):

- The ”Norway model” where the UK joins the European Economic Area (EEA)
- The ”Switzerland model” where the UK negotiates a set of bilateral agreements with EU27 regarding trade and factor flows
- The ”Turkey model” where the UK enters into a customs union with EU27
- A Preferential Trade Agreement (PTA) scenario where tariffs on goods traded between the UK and EU27 are partially removed or trade is fully liberalized in which case we refer to it as a Free Trade Agreement (FTA)
- WTO scenario where the UK trades with EU27 (and all other WTO members) on MFN terms

The political process for Brexit just got started and clarities on the likely outcomes will not be known in the near future. In the current study we therefore focus on two relevant benchmark scenarios:

- FTA scenario implying zero tariffs on trade between the UK and EU27 (“optimistic” scenario).
- WTO scenario where the UK trades with EU27 on MFN terms (“pessimistic” scenario)

[7] Agricultural and food products are defined as the aggregate of product categories 1-12 and 14-22 in the aggregated GTAP database used in this study. For details of these product categories, see Appendix Table 2a.

Both scenarios are evaluated against a baseline in which the UK is assumed to stay in the EU. There are several reasons for focusing on these two particular scenarios rather than the other scenarios mentioned above such as the "Switzerland" and "Norway" models. First, it is difficult to formally model deep economic integration á la the "Switzerland" and "Norway" models due to their complexity. Second, neither of the "Switzerland" and "Norway" agreements covers trade in agricultural products which is the main focus of this study, and this is also the case for the custom union between EU and Turkey. Third, the WTO scenario is the most extreme scenario in terms of rising trade costs between the UK and EU, as well as between the UK and the EU's FTA trade partners; therefore it is expected that this arrangement would lead to large negative trade effects in a "worst" case or "pessimistic" scenario. All other scenarios will lead to impacts that are somewhere in between those resulted from the WTO scenario and the *status quo* (i.e. the UK remaining in the EU single market). As the *status quo* is effectively ruled out by Brexit itself, the best hope for the UK to maintain closer trade ties to the EU will have to be some kind of PTA as a "best" case or "optimistic" scenario. We therefore assess the potential scope of such an arrangement in an FTA scenario in which we assume that the two parties agree to remove all tariff barriers.

It is important to understand that, even if the UK manages to negotiate an FTA with EU27, such that goods trade will not be subject to tariff barriers, this will presumably still lead to an increase in overall trade costs. This is partly due to the introduction of border measures required to deal with country of origin matters. Moreover, firms will face additional production costs on their exported goods due to regulatory divergences over time. For example, future health and labelling standards imposed on goods for domestic consumption by the UK government might be different from those applying to goods consumed within EU27. Exactly how high the costs are associated with non-tariff barriers (NTBs) is an empirical question which is subject to considerable debate.

Options for UK-Third countries arrangements

The EU has a large number of PTAs with third countries. In fact, according to the WTO, the EU currently trades on MFN terms with only 30 countries among which, however, are some of the world's largest agricultural exporters, such as Argentina, Australia, Brazil, Canada, New Zealand, Russia and the United States. We assume that following Brexit, the UK will have to leave all PTAs it currently is a party to as an EU member state. Moreover, the EU is a party to several ongoing trade negotiations which UK will lose out on as well, should they materialize in the future. In particular, we assume that

the UK will not be able to reach a PTA with Canada, USA or any other country in the time horizon under consideration.

In summary, this study assumes an exit of the UK from EU27's PTAs under both the WTO and FTA scenarios. The UK could, of course, choose to liberalize its trade policy by reducing its MFN tariffs unilaterally. However, we will assume that WTO MFN tariffs will apply where applicable implying that trade between the UK and relevant third countries will be subject to each of the respective countries' MFN tariffs.

3 Methodology, data and scenarios

To understand the potential impacts of different Brexit scenarios on the Danish economy, particularly on the agricultural sectors including possible changes in bilateral and total trade flows, sectoral production and employment effects, a quantitative economic model is needed. Such a model should possess modeling structure and behavior to track the economy-wide and sector specific effects of policy changes associated with the assumed Brexit scenarios, not only regarding the implied changes on trade flows due to changing bilateral trade costs such as import tariffs and non-tariff barriers but also on how changing trade flows influence domestic production and consumption at sectoral and aggregated levels. These requirements point to the use of the trade-focused computable general equilibrium (CGE) models. Typical CGE models are firmly based on microeconomic theory as they assume utility-maximizing consumers and profit-maximizing (or cost minimizing) producers, allow for inter-sectoral linkages through input-output linkages and competitions on the factors markets, and observe resource constraints with regard to all factor markets. Among existing CGE models, trade focused models have been used extensively in the trade policy literature, particularly for *ex ante* evaluations of changes in trade policy due to formations of preferential trade agreements and of options of trade negotiations involving multiple partner countries.

In this respect, the global CGE modelling framework and database nicknamed GTAP, developed in Hertel and Tsigas (1997), is well suited for such purposes. The GTAP model is a widely used multi-sector and multi-region computable general equilibrium model of the world economy. The standard GTAP model assumes perfectly competitive markets and constant returns to scale technology. Nested constant elasticity of substitution production functions are defined over intermediate inputs and primary production factors such as land, capital, skilled and unskilled labors and natural resources. On the demand side, private demand of a representative private household follows a constant

difference in elasticity demand function, which in turn enters into the aggregated demand function together with government and saving demands. Countries and regions in the model are linked through international trade linkages specified in the Armington structure and a global bank sector that intermediates global savings and consumptions (for details see Hertel and Tsigas, 1997).

Typical *ex ante* modeling exercises with the GTAP model involves computing a new equilibrium solution to the model due to "exogenous" changes to a set of policy variables from the levels embodied in the benchmark equilibrium data set (which itself is an equilibrium solution to the model). In the case of trade policy changes such as those assumed in the case of Brexit, the differences between the new and benchmark equilibria can then be considered as the effects of the assumed policy changes. Aside from the assumed changes in policy variables to be discussed in the next subsection, another complication is to choose and construct a "business-as-usual" baseline from which the new equilibrium solution is to be computed. In this case, the baseline has to be chosen in a year where the Brexit scenarios are assumed to take effect. Given the difficulties in predicting when and what kind of arrangements will be reached, this paper opts for a simple assumption that the analyzed Brexit scenarios would take effect in the year 2021, under the assumptions that Britain would start the negotiation process in 2017 and concluding the process within the pre-set 2-year period.

In the rest of this section, we proceed to the discussion on the baseline, the assumed scenarios, and the data used to characterize the scenarios, particularly with respect to the assumed changes to import tariffs and ad valorem equivalence of non-tariff barriers.

3.1 Descriptions of the Baseline and Scenarios

3.1.1 Database and baseline construction

The most recent and publically available GTAP database has base years in 2004, 2008, and 2011, essentially providing three benchmark equilibrium datasets as solutions to the GTAP model. We choose the 2011 data set for our purposes as it contains the most up-to-date data and is closest to the assumed baseline year of 2021.[8]

The GTAP database contains data for 140 countries and 57 sectors. To limit the computation burden and for ease of presentation of the results, an aggregated version along both the country and sector

[8] As the analysis is built upon the baseline of 2021, a general equilibrium data set with more recent base year would be more desirable for projecting the world economy to the baseline year of 2021. However, compiling such a data set is a huge undertaking and generally occurs at a time lag of several years.

dimensions are used for this analysis. This version covers 28 sectors including 21 agricultural and food sectors, 1 aggregated extraction sector, 3 aggregated manufacturing sectors and 3 service sectors, and 39 countries and aggregated regions covering multiple countries. A detailed list of sectoral and country aggregations is provided in Appendix Tables 2a and 2b. Within the EU, Denmark, France, Germany, Ireland, Italy, Netherlands, Poland, Spain, and the UK are included as individual countries and the rest of the EU is aggregated together. Additionally, another 30 countries/regions are included. The selection of additional individual countries is based on the economic size and other considerations such as whether these countries are part of a preferential trade agreement with the EU.

The construction of the 2021 baseline is essentially an extrapolation of the 2011 GTAP dataset to the year 2021 by targeting current projections on GDP, labor force and population growth for all countries and regions included in the model during the 2011-2021 period, while allowing capital and total factor productivities to adjust to accommodate the above targets. The data on the targets are sourced from Fouré et al. (2012).

In addition to the macro economic assumptions and adjustment above, in the baseline the following assumptions are also adopted: that the UK remains a member of the EU implying no changes to the bilateral trade relationship between the two; that existing preferential trade arrangements of the EU are maintained, with the UK being a full member in these arrangements; and that several "likely" FTAs of the EU are also fully implemented, with the UK being a full member in these new FTAs, including those with Canada, Mexico, Mercosur, Japan, and several individual members of ASEAN (Vietnam, Thailand, Indonesia, and the Philippines). This implies that the bilateral tariff barriers within these arrangements are removed. Possible future FTAs with the US, Australia, New Zealand, and Turkey (agriculture sectors) are excluded from the baseline, due to considerations of the current negotiation status. This means that the *status quo* regarding bilateral trade relationships between the EU and these countries is maintained in the baseline; similarly, no changes to the bilateral trade relationship between the UK and these countries are assumed in the Brexit scenarios to be detailed below.

3.1.2 Description of the scenarios

Following earlier discussions in this study, two core scenarios are considered in this study, namely the FTA scenario under which the UK forms a free trade area with the EU, and the WTO scenario where the UK and EU treat each other's exports on the WTO MFN terms. In the first scenario, zero

tariffs are assumed between the UK and EU for all products. However, non-tariff barriers related to standards and regulatory differences would rise, so would the cost related to the need to establish rules of origin. These considerations effectively increase trade costs between the two sides. In the case of the WTO scenario, the UK and EU are assumed to raise the bilateral import tariff rates to the levels of the EU's common external tariffs, as these also represent the UK's MFN tariff in the WTO. Moreover, non-tariff measures also rise in this case.

Therefore, the bilateral trade barriers in both scenarios rise for the UK and EU. Additionally, as discussed earlier, we also assume the UK has to exit the various PTAs negotiated by the EU with third countries. As such, bilateral tariffs between the UK and these third countries have to rise to their respective WTO MFN levels in both scenarios.

3.2 Data on tariffs and non-tariff barriers

This section provides a more detailed account on the data underlying the two core scenarios, including both import tariffs and ad valorem equivalence of non-tariff barriers.

3.2.1 MFN tariffs of the EU

Figure 1 illustrates EU's current MFN tariffs. The numbers, which are based on the GTAP database, are averages of the individual tariff lines belonging to each of the 28 product categories considered in this study, weighted by the amount of import from the main EU MFN trade partners.

One major difficulty of such an aggregation exercise is that many of the underlying individual tariff lines are specific tariffs or a mix of specific and ad valorem tariffs. To take an example, consider "Fresh, chilled or frozen cuts of sheep with bone in" with the six digit HS12 number 020422. This product category consists of 4 underlying (8 digit) tariff lines (referring to more specific cuts). EU's applied MFN tariffs on imports of these cuts of sheep consists of an ad valorem tariff of 12.8% + a specific tariff ranging from 119.9 to 222.7 EUR/100 kg.[9] In order to find the ad-valorem equivalent (AVE) tariff of each of these mixed tariffs one needs to know the quantity and value of the affected trade flows for determining a unit value as a base for finding the AVE.

Another complication arises from the fact that the trade values that are needed to calculate AVEs of specific tariffs are affected by the tariffs themselves. This issue also makes it difficult to calculate appropriate average AVEs for the aggregated product categories. On the one hand, it does not make

[9] This information is obtained from the http://tariffdata.wto.org/Default.aspx on the WTO website.

sense to take a simple average of the AVE tariffs of the underlying disaggregated tariff lines since it implies that all products are weighted equally. On the other hand, a weighted average where tariffs applied to trade flows representing the most value are given larger weights will be biased towards zero exactly because high tariffs reduce trade.

In light of these issues the EU MFN tariffs illustrated in Figure 1 are not calculated from the raw tariff data available from the WTO. Instead we used the MAcMap-HS6 database of tariff protection which is part of the GTAP database (see Guimbard et al., 2012), where all tariffs have been converted to their AVEs (which solves the first challenge mentioned above). Specifically, we compiled a list of countries trading with the EU on MFN terms. Then, we calculated the average AVE tariff for each of the 28 aggregated product categories considered in this report, where each individual tariff line is weighted by the corresponding value of EU's import from all its MFN partners. Although this procedure does not take care of the bias problem entirely, as a practical solution it generates more sensible aggregated average tariffs compared to the bilateral trade shared-weighted tariffs, because the trade weights chosen here likely to be less biased than trade weights associated with one particular trade partner. In essence, the logic behind this method is similar to the reference group weighting method used for compiling the MAcMap-HS6 database at HS-6 level.

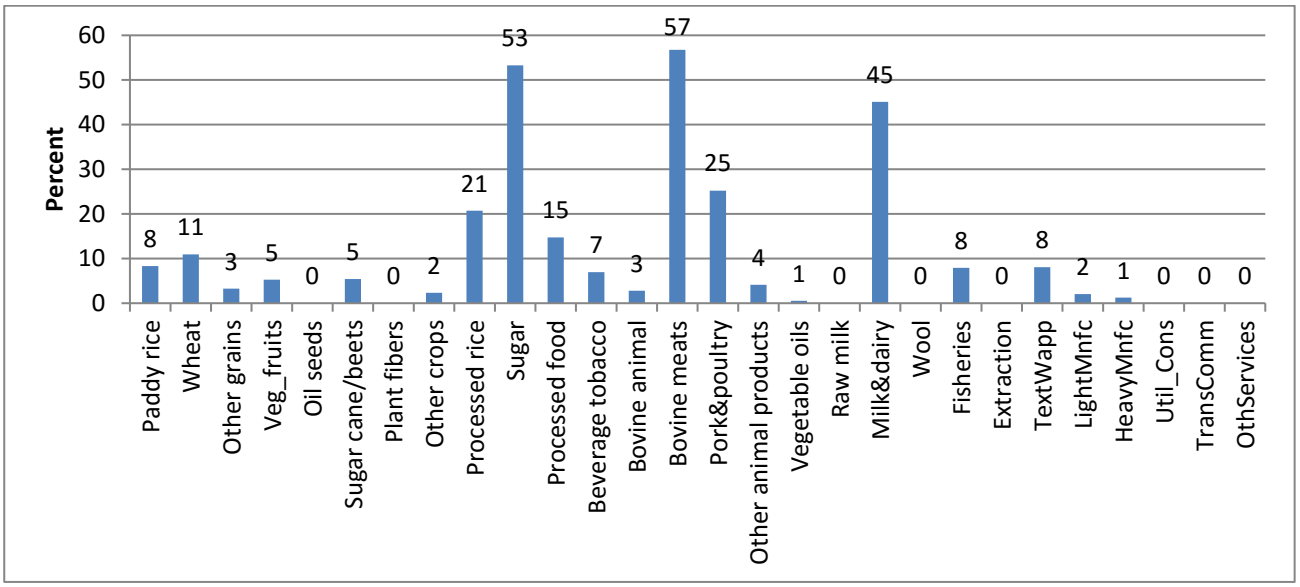

Figure 1. EU MFN tariffs. Source: Own calculations based on the GTAP database. Note: labels refer to product categories according to the GTAP classification

As can be seen from Figure 1 above, the EU sectors with the highest levels of protection are sugar, bovine meat, pork and poultry, and milk and dairy. It should be noted that pork and poultry, and milk and dairy are among key exports from Denmark to the UK.

3.2.2 MFN tariffs of the third countries

As discussed earlier, another complication arising from BREXIT is that the UK may need to exit all PTAs negotiated by the EU, as assumed in both of our scenarios. Therefore, we need to find the aggregated MFN tariffs that would be imposed by these countries on the UK exports. We follow the same procedure outlined in the previous section to generate these aggregated average MFN tariffs.

Table **2** presents the aggregated average MFN tariffs on the 28 product categories for 7 important countries with an existing EU PTA. The numbers are calculated the same way as those in Figure 1 i.e. they represent averages of individual disaggregated tariffs weighted by each of the countries' imports from its major trade partners. It is worth noting that these countries have very high MFN tariffs on several food products but there are quite a lot of variations across countries and products. We are assuming that the UK will be facing these tariffs when exporting to these countries following Brexit. On the other hand, these countries will be facing the current EU MFN tariffs shown in Figure 1 when exporting to the UK. Trade between EU27 and the countries listed in Table 1 will be subject to the existing preferential import tariffs.

Similarly, we assume in both scenarios that the UK would not be part of the PTAs that are currently under negotiations. As these PTAs are assumed to be implemented by 2021, the MFN tariffs of the partner countries to these future PTAs would also prevail for exports originated from the UK.

Table 2. Third-country MFN tariffs on food import by partner countries in existing EU PTAs (%)

	Korea	**Switzerland**	**Norway**	**Turkey**	**Ukraine**	**South Africa**	**Egypt**
Paddy rice	5.0	0.4	17.5	32.0	4.3	0.0	1.7
Wheat	1.7	37.7	125.2	65.0	1.4	0.0	0.0
Other grains	426.3	10.5	90.2	42.4	0.4	0.7	0.0
Veg_fruits	46.5	8.1	7.6	25.0	2.5	7.2	2.4
Oilseeds	420.1	11.8	17.9	4.2	4.4	8.6	0.2
Sugar cane/beets	0.3	0.0	0.0	0.0	0.0	0.0	0.0
Plant fibers	0.0	0.0	0.0	0.0	0.0	7.8	0.0
Other crops	34.7	5.0	12.3	22.9	1.6	51.2	9.0
Processed rice	5.0	1.7	11.9	28.6	4.9	0.0	2.0
Sugar	9.4	3.8	55.8	31.2	49.4	0.0	2.5
Processed food	40.7	9.2	19.3	15.7	5.3	7.2	43.2
Beverage tobacco	55.0	16.4	9.5	9.3	9.7	6.6	526.7
Bovine animal	8.6	35.6	1.7	18.6	0.0	0.0	0.0
Bovine meats	34.7	47.3	178.7	2.0	13.8	16.4	1.0
Pork&poultry	24.3	75.6	17.3	10.4	10.0	14.2	29.4
Other animal products	6.2	1.4	1.1	3.1	6.9	1.0	2.1

Vegetable oils	7.3	37.7	41.8	16.4	0.4	8.2	2.2
Raw milk	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Milk&dairy	58.3	58.0	32.3	166.3	9.4	12.7	4.8
Wool	3.0	0.0	0.0	0.0	0.0	0.0	0.0
Fisheries	17.0	0.1	0.2	32.1	7.1	1.5	4.8

Source: Own calculations based on the GTAP database

Table 3. Third-country MFN tariffs on food import by realistic future EU27 PTA partners (%)

	Canada	**Vietnam**	**Japan**	**Brazil**	**Argentia**	**Thailand**	**IdnPhl**	**Mexico**
Paddy rice	0.0	39.8	410.6	7.7	3.0	30.0	50.0	0.0
Wheat	0.0	1.7	22.1	4.9	4.8	27.0	4.1	0.1
Other grains	0.0	13.4	8.0	2.8	0.5	20.7	5.3	6.0
Veg_fruits	0.1	20.8	12.3	10.7	8.7	26.7	6.6	32.1
Oilseeds	0.0	0.1	1.2	4.1	4.0	13.2	2.5	0.4
Sugar cane/beets	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
Plant fibers	0.0	0.0	0.0	8.7	5.6	0.0	0.0	0.0
Other crops	0.6	22.6	0.3	3.7	2.4	36.0	5.1	2.3
Processed rice	0.0	27.8	241.2	8.5	2.6	23.0	9.0	0.3
Sugar	0.1	12.3	14.5	11.3	8.1	36.6	9.6	41.2
Processed food	12.7	12.8	10.9	11.7	12.6	8.3	10.1	14.8
Beverage tobacco	2.9	45.5	6.8	19.9	18.0	26.7	10.7	2.1
Bovine animal	0.0	0.2	10.4	0.5	0.4	5.2	4.7	0.0
Bovine meats	0.5	12.1	33.8	7.7	4.4	31.0	7.2	11.2
Pork&poultry	56.4	15.3	62.4	10.4	7.8	3.2	24.9	11.9
Other animal products	15.6	1.0	4.8	5.7	3.5	7.0	4.5	2.6
Vegetable oils	6.0	0.6	2.0	10.0	11.5	15.5	1.6	1.2
Raw milk	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Milk&dairy	201.4	3.6	61.8	15.3	17.6	11.6	3.7	26.7
Wool	0.0	0.2	23.6	0.0	7.6	0.1	0.3	1.0
Fisheries	0.0	4.1	4.6	4.8	1.2	5.5	4.6	10.4

Source: Own calculations based on the GTAP database. Note: Brazil, Argentina and Mexico are currently negotiating an FTA with the EU as members of the Mercosur FTA

Table **3** presents the MFN tariffs for eight countries that are currently negotiating PTAs with the EU. As in Table 2, there are a lot of variations in the tariffs applied to imports of different products within and across these countries. We are assuming that the UK exports to these countries will be subject to the tariffs in Table **2** following Brexit; moreover, tariffs applying to trade between the countries listed in Table 2 and the EU27 will be removed completely in the baseline and remains zero in the two

scenarios. That is, we are assuming that the countries listed in Table 2 manage to agree on an FTA with EU27 covering all products. Finally,Table 4 shows the MFN tariffs of 3 possible future EU27 PTA partners that will be imposed by these partners on exports from the UK. Note that these countries have relatively low tariffs on all products.

Table 4. Third-country MFN tariffs on food import. Possible future EU27 PTA partners (%)

	Australia	New Zealand	USA
Paddy rice	0.0	0.0	1.3
Wheat	0.0	0.0	1.6
Other grains	0.0	0.0	0.1
Veg_fruits	0.3	0.0	1.0
Oilseeds	0.0	0.0	1.2
Sugar cane/beets	0.0	0.0	0.1
Plant fibers	0.0	0.0	0.0
Other crops	0.1	0.2	1.2
Processed rice	0.0	0.0	3.7
Sugar	0.0	0.0	12.3
Processed food	2.0	2.8	3.2
Beverage tobacco	2.9	2.1	1.1
Bovine animal	0.0	0.0	2.5
Bovine meats	0.0	0.2	2.9
Pork&poultry	0.1	2.6	1.1
Other animal products	0.2	0.0	0.5
Vegetable oils	0.1	0.2	1.6
Raw milk	0.0	0.0	0.0
Milk&dairy	4.6	3.8	10.5
Wool	0.0	0.0	0.4
Fisheries	0.9	0.0	0.2

Source: Own calculations based on the GTAP database.

In terms of implementation of the baseline and scenarios, the baseline represents the situation where the UK would be part of these existing and future PTAs, therefore exports from the UK would be subject to the preferential tariffs. In the WTO and FTA scenarios, however, exports from the UK would be met with the MFN tariffs on the markets of the third countries, implying that tariffs would rise to the relevant MFN levels presented in tables 2-5.

3.2.3 NTBs in the scenarios

Figure 2 illustrates our assumptions regarding administrative trade costs in *ad valorem* equivalents (AVEs) applying to trade flows between FTA partners as compared with EU's common market. That

is, the numbers indicate how much higher the UK-EU27 trade costs will be if the UK manages to negotiate an FTA with EU27 following Brexit.

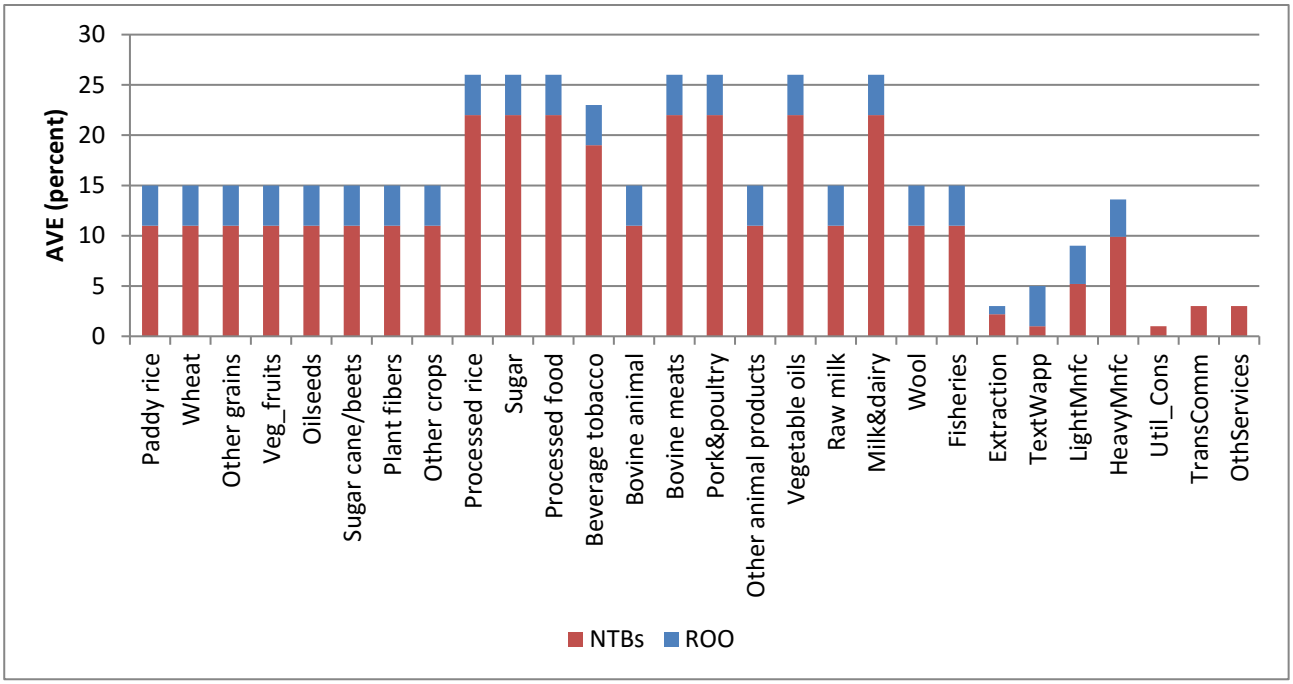

Figure 2. NTBs in the FTA scenario. Source: Own calculations based on Egger et al. (2015)

The numbers are based on those in Egger et al. (2015) but adapted to the aggregation scheme used in this report. We distinguish between two types of administrative trade costs, namely Rules of Origin (ROO) costs and regulatory barriers (NTBs).

ROO costs are incurred when officials must spend resources determining the extent to which an imported product is produced in a PTA partner country rather than a third-country without preferential access. In line with the literature we assume that ROO costs amount to 4 percent of the CIF (Cost, Insurance and Freight) price in most cases (e.g. Carrère and De Melo, 2006). NTBs (Non-Tariff Barriers) are costs associated with regulatory differences across countries such as labelling requirements, health standards, control procedures etc. Although UK's regulation is currently based on the EU one, it is assumed that the two will diverge over time following Brexit. When a product must satisfy different standards in different markets producers must devote resources to comply with these different rules which increase costs. We therefore assume that CIF prices on goods traded between EU27 and the UK will increase by these amounts in FTA scenario. It should be noted that these numbers are subject to considerable uncertainty.

Figure 3 illustrates the NTB costs in ad valorem equivalents that we assume apply to trade flows between MFN trade partners. EU's current MFN tariffs from Figure 1 are also shown for comparison. The source of the NTB numbers is the same as above. In general, current literature finds that the EU's NTBs for agriculture imports from non-EU member states are much higher than the corresponding MFN tariffs, indicating that the NTBs may be a more important trade barrier for the UK and EU27 to access each other's markets following Brexit.

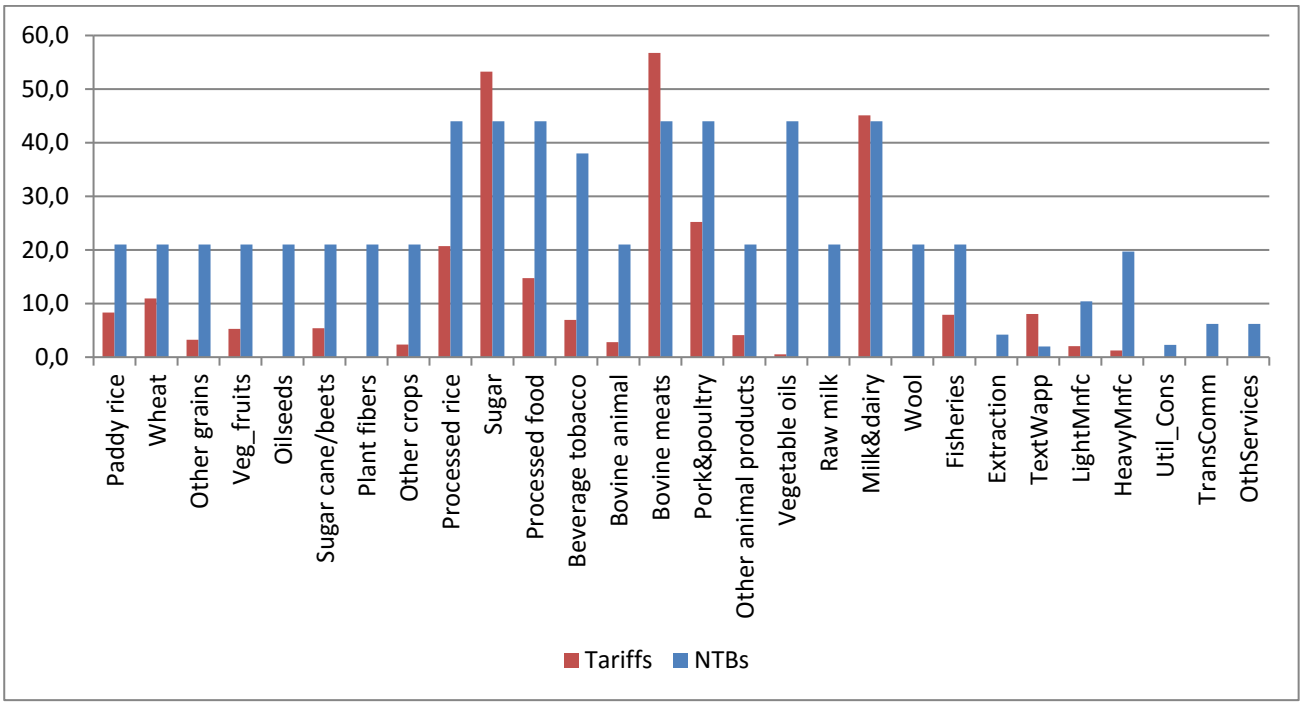

Figure 3. NTBs in the WTO scenario. Source: Own calculations based on Egger et al. (2015)

As also found in the literature (e.g. Egger et al., 2015), NTB costs are higher when trade partners are not part of a PTA and therefore trade on WTO MFN basis. In the context of the EU and UK, the reason that NTB costs are higher in the WTO scenario than in the FTA scenario is due to additional regulatory divergences between EU27 and the UK in the latter scenario. Based on the estimates of Egger et al. (2015) and following the application of their estimates in Rojas-Romagosa (2016), we assume that the NTBs in the WTO scenario are twice as high as in the FTA scenario which makes them much higher than the tariffs for most of the product categories, as can be seen in Figure 3 (also note that we assume zero ROO costs in the WTO scenario). For instance, the AVEs of the NTBs in the crop sectors are above 20 percent and are much higher than the corresponding MFN tariff rates; in the case of processed food, beverage and tobacco, and meat and dairy products, the AVEs of the associated NTBs exceed 40 percent. Therefore, it is expected that much of the trade-reducing effects

of Brexit under the WTO scenario will be driven by these assumptions. Owing to the fact that current literature only contains relatively few estimates on the NTBs (such as the widely referenced estimates from Egger et al. (2015)), caution should be exercised when perusing the results based on these estimates.

4 Results

This section first reports the main simulation results at sectoral levels, including changes in bilateral trade flows from Denmark to the UK with focus on key agricultural sectors, and changes in sectoral outputs and employment. Following that, key aggregated results are also reported, mainly on GDP. In addition to reporting the total effects for the two scenarios, a decomposition analysis is also offered regarding how changes in trade barriers by different parties (i.e. UK, EU27, and third countries) and different types of trade costs (i.e. NTBs vs. import tariffs) contribute to the total effects. In relation to the latter point and for clarity of presentation, an extra simulation is conducted in the WTO scenario where the MFN tariffs are assumed but not the NTBs. This extra scenario is named WTO-MFN only and the complete WTO scenario is named WTO MFN+NTB. It should also be noted that the results reported here are based on a comparative static framework whereby the assumed time horizon is of the "medium run" nature. In addition, several likely EU FTAs with third countries are assumed in the baseline; therefore, the results reported here reflect these assumptions as well.

4.1 Bilateral and total export flows from Denmark

With rising bilateral trade costs, Danish exports of key agri-food products to the UK would drop from the baseline levels in both the WTO and FTA scenarios. The magnitude of changes from the baseline depends on the assumed rising trade costs. For instance, as shown in Table **5**, exports of processed food products, pork and poultry, and milk and dairy products are predicted to decrease by between 71 and 94 percent under the WTO MFN+NTB scenario, due to the assumed increase in both MFN tariffs and NTBs, whereas in the case of the FTA scenario, decreases in bilateral exports to the UK are in the order of 44 (processed food) to 56 percent (for milk and dairy). Under the WTO MFN+NTB scenario, the assumed increases in NTBs appear to be more damaging (than the MFN tariffs) to many of Denmark's exports to the UK, as can be seen from the first column in Table 5 where the effects from raising the MFN tariffs only (i.e. the WTO MFN only scenario) are reported. In that case, reductions in bilateral exports to the UK for other food, pork and poultry, and milk and dairy would be about 26, 47, and 74 percent (as compared to 71, 94 and 93 percent) respectively.

Overall, simulation results suggest that total Danish exports to the UK would be reduced from the baseline by nearly 51 percent under the WTO MFN+NTB scenario and 36 percent under the FTA scenario (see Table 6). Within the WTO scenario, if the assumed NTBs were absent, total Danish exports to the UK would only drop by 10 percent. For agri-food products, Danish exports to the UK would decrease more in both the WTO and FTA scenarios (79 and nearly 48 percent, respectively), as compared to the aforementioned results for total bilateral exports. This reflects the higher trade costs that would be imposed on agri-food exports under the two Brexit scenarios. Similarly, when the assumed NTBs were absent under the WTO scenario, Danish agri-food exports would be reduced by about 39 percent, about half of the simulated percentage changes when rising trade costs associated with the assumed NTB are considered.

Table 5. Changes in bilateral exports from Denmark to UK, % from baseline

	WTO (MFN only)	WTO (MFN+NTB)	FTA
Vegetable and Fruits	-7.4	-38.5	-24.7
Oilseeds	0.1	-59	-48.9
processed foods	-25.9	-70.7	-44.3
beverage_tabacco	-8.5	-41.8	-26.6
Bovinemeats	-93.6	-97.7	-70.5
Porkpoultry	-46.7	-94.3	-51
other animal products	10.4	-14	-7.2
vegetable oils	-1.7	-85.7	-68.5
Milkdairy	-73.8	-92.6	-56.6

Note: WTO (MFN only) refers to the WTO scenario with increasing MFN tariff only; WTO (MFN+NTB) refers to the WTO scenario with increasing MFN tariffs and rising NTBs; FTA refers to the FTA scenario. Source: simulation results by authors.

Table 6. Bilateral exports from Denmark to UK (million USD)

	2011	2021 baseline	WTO (MFN only)	WTO (MFN+NTB)	FTA
Vegetable and Fruits	3.8	4.1	3.8	2.5	3.1
Oilseeds	0.4	0.5	0.5	0.2	0.3
Processed food products	**739**	**708**	**524**	**207**	**393**
Beverage&tabacco	44	45	41	26	33
Bovinemeats	34	27	2	1	8
Pork&poultry	**1068**	**565**	**301**	**32**	**276**
Other animal products	7	8	9	7	7
Vegetable oil	14	14	14	2	5
Milk&dairy	**342**	**280**	**73**	**21**	**121**

Total	**11,296**	**11,024**	**9,894**	**5,432**	**7,085**
Total agrifood	**2,368**	**1,803**	**1,103**	**372**	**945**
% from base2021, agrifood products			**-38.8**	**-79.3**	**-47.6**
% from base2021, all products			**-10.3**	**-50.7**	**-35.7**

Source: simulation results by authors.

While the simulation results for the two Brexit scenarios point to very large reductions in Danish exports to the UK, particularly for processed foods, pork products, and milk and dairy, total Danish exports may not drop as much even though the UK is an important destination for Danish exports. This is because the remaining EU single market which is still much larger than the UK market would allow for potentials to redirect significant exports within the single market in the event of rising trade costs on the UK market. Additionally, trade costs for exporting to third countries' markets are either assumed to be unchanged or lowered (due to the additional PTAs of the EU) in the baseline, relatively speaking these markets become more attractive for Danish exports as compared to the UK market. Therefore, these third country markets provide another channel for re-directing Danish exports.

Table 7. Changes in total exports from Denmark, % from baseline

	WTO (MFN only)	WTO (MFN+NTB)	FTA
Vegetable and Fruits	0.8	1.9	1
Oilseeds	0.8	3.1	1.8
Processed foods	-1.3	-4.1	-2.4
Beverage_tobacco	0.4	0.5	0.4
Bovinemeats	-1.4	1.3	1.1
Porkpoultry	-1.6	-2.7	-1.3
Other animal products	0.6	1.6	1
Vegetable oils	0.3	-1.7	-1.6
Milk&dairy	-3.3	-3.3	-1.3

Source: simulation results by authors.

Indeed, simulation results reported in Table **7** suggest very modest reductions in total Danish agri-food exports under both the WTO and FTA scenarios. For processed foods, pork and poultry, and milk and dairy products, total exports would drop by 4.1, 2.7, and 3.3 percent under the WTO MFN+NTB scenario and by 2.4, 1.3 and 1.3 percent under the FTA scenario. Note that these simulated percentage reductions of total exports are far smaller than the percentage changes reported for Danish exports destined to the UK markets, even after those percentage changes are scaled down by UK's shares of total Danish exports. This is indeed consistent with additional simulation results (as reported in Appendix Table 3 for the case of pork products) that Danish exports to other markets

rise, particularly for products that would be affected the most by Brexit. In the case of pork products, simulation results from the WTO scenario reported in Appendix Table 3 suggest notable increases in exports to non-EU markets such as China and Japan, among others. Within the EU, pork exports are expected to rise for Germany, Poland, Ireland, Italy and France. These increases would lead to a smaller overall reduction in pork export volume from Denmark as well as an even smaller percentage reduction.[10]

Overall, total Danish exports would drop by 0.43 and 0.29 percent in the WTO and FTA scenarios (as reported in Appendix Table 4), as compared to the much larger decreases in overall exports from the UK at respectively 9.33 and 7.23 percent in the same two scenarios. These aggregated results again demonstrate the asymmetric nature of the negative trade effects of Brexit, with the negative burden being placed disproportionately larger on the UK. By the same measure, most other EU member states would also suffer from Brexit, notably Ireland, the Netherlands, Poland, France, Italy and Germany. On the other hand, marginal increases in total exports are expected from countries such as Vietnam, Thailand, Switzerland, and Turkey. These countries – which either have already completed PTAs with the EU or are assumed to have concluded PTAs with the EU in the baseline – are expected to increase their trade flows with the EU27, while trade flows between the UK and EU27 are expected to shrink due to Brexit.

4.2 Changes in domestic outputs

Results from section 4.1 suggest very large reductions in agri-food exports from Denmark to the UK but quite modest reductions in total agri-food exports from Denmark. Therefore, it is expected that the domestic market effects of Brexit for the Danish agricultural sectors are to be mainly influenced by the simulated total export effect rather than the effect on bilateral exports to the UK. Table **8** provides the simulated results due to the WTO (including both the WTO MFN and WTO MFN+NTB scenarios) and the FTA scenarios.

For the three key agri-food sectors (i.e. processed foods, pork and poultry, and milk and dairy), the main WTO scenario (i.e. WTO MFN+NTB) would lead to reductions in domestic output similar in magnitude to those of total Danish exports, ranging from 2.5 percent for processed foods, 2.2 percent for pork and poultry , to 1.1 percent for milk and dairy. Without considering rising NTBs, as in the

[10] Given the contrast between the very large impacts on bilateral exports from Denmark to the UK caused by reductions in tariffs and NTBs and the much smaller impacts on overall Danish exports, the uncertainties associated with the underlying assumptions on the NTBs are unlikely to have substantial impact on the size of the latter effect.

WTO MFN scenario, decreases in domestic outputs would be mostly smaller, with domestic outputs for processed foods, pork and poultry, and milk and dairy dropping by 0.8, 1.2 and 1.1 percent respectively. Under the FTA scenario, reductions in domestic outputs are also of smaller magnitude for these three key products (by 1.4, 1, and 0.3 percent respectively).

Table 8. Changes in domestic production, % from baseline

	WTO (MFN only)	WTO (MFN+NTB)	FTA
Vegetable and Fruits	0.46	0.99	0.55
oilseeds	0.58	2.22	1.26
other crops	0.24	-0.15	-0.38
processed foods	-0.76	-2.51	-1.44
beverage_tabacco	0.12	0.24	0.16
bovinemeats	-0.54	1.31	1.05
Porkpoultry	-1.22	-2.17	-1.01
other animal products	-0.63	-1.02	-0.4
vegetable oils	0.17	-1.34	-1.19
Milkdairy	-1.09	-1.08	-0.26
Fishery	-0.06	-0.01	-0.02

Source: simulation results by authors.

Another simulation result deserving some attention is the slight increase of total exports of several other agrifood products such as vegetable and fruits, oilseeds, beverage and tobacco, bovine meats and other animal products by between 0.5 to 3.1 percent (see Table 7). These products are not currently heavily exported by Denmark to the UK and therefore are products that would be directly impacted relatively little by the assumed Brexit scenarios. However, as a result of resource reallocations associated with decreasing total exports and outputs in some key agrifood sectors, these sectors that would be relatively unaffected by Brexit would attract economic resources such as labor and land away from those negatively impacted sectors in a general equilibrium setting, particularly in the medium and longer run. In fact, even though Danish exports of these products to the UK are currently very small, total Danish exports of these products to the world are not negligible (particularly for beverage and tobacco and bovine meats). This explains their rising outputs and exports.

4.3 Employment effects

Underlying the simulated changes in domestic outputs reported in section 4.2 are reallocations of economic resources such as primary production factors (i.e. land, labor, and capital), as well as changing demand for intermediate inputs. Of particular societal concern is the possible employment effect arising from the assumed Brexit scenarios. While the GTAP model used for the current study

assumes full employment of all primary factors including skilled and unskilled labor and the simulation results are of the "medium run" nature (i.e. all markets including factor markets are in equilibrium), the simulated changes in sectoral employment may be considered an indication of sectoral unemployment, particularly in the short run where the labor market is adjusting to accommodate the reallocated workers in other sectors.

Table 9. Changes in sectoral employment, % from baseline

	WTO (MFN only)		**MFN (MFN+NTB)**		**FTA**	
	Unskilled labor	Skilled labor	Unskilled labor	Skilled labor	Unskilled labor	Skilled labor
Vegetable and Fruits	0.4	0.4	0.95	0.91	0.56	0.53
Oilseeds	0.53	0.52	2.24	2.21	1.3	1.28
Processed food products	-0.74	-0.77	-2.4	-2.6	-1.4	-1.5
Beverage&tabacco	0.14	0.11	0.3	0.2	0.2	0.1
Bovine animal	-0.39	-0.39	1.0	1.0	0.8	0.8
Bovinemeats	-0.52	-0.55	1.4	1.3	1.1	1.0
Pork&poultry	-1.2	-1.23	-2.1	-2.2	-1.0	-1.0
other animal products	-0.76	-0.77	-1.2	-1.2	-0.5	-0.5
vegetable oil	0.19	0.16	-1.3	-1.4	-1.1	-1.2
Raw milk	-1.11	-1.12	-1.3	-1.3	-0.4	-0.4
milk&dairy	-1.07	-1.1	-1.0	-1.1	-0.2	-0.3

Source: simulation results by authors.

Table **9** therefore reports simulated changes in sectoral employment for both skilled and unskilled workers in the Danish agricultural sectors. Under the WTO MFN+NTB scenario, Danish processed foods, pork and poultry, and milk and dairy sectors are expected to experience reduced employment of unskilled workers by respectively 2.4, 2.1, and 1 percent and employment of skilled workers by similar magnitudes. Without the assumed increase in NTBs (i.e. WTO MFN only scenario), simulated reduction of sectoral employment in processed food sector would be about one-third of that under the WTO MFN+NTB scenario; for pork and poultry, employment would be reduced by about 1.2 percent; for the milk and dairy sector, the employment effect would be similar between the WTO MFN and WTO MFN+NTB scenarios (however, labor force in producing raw milk would shrink more in the latter scenario). Under the FTA scenario, smaller simulated reductions of sectoral employment are observed, as compared to the WTO MFN+NTB scenario, with unskilled (skilled) employment for processed foods, pork and poultry, and milk and dairy dropping by 1.4 (1.5), 1.1 (1), and 0.2 (0.3) percent, respectively.

4.4 Macroeconomic effects

To measure the macroeconomic impacts of the two Brexit scenarios, changes of gross national products (GDP) from the baseline are presented in Table 10. Other macroeconomic effects such as changes in price levels and economic welfare can also be potentially interesting[11]; however, as the main focus of the report is on Danish industry interests, GDP appears to be a more appropriate measure for discussion. To develop some comparative perspectives, in what follows we discuss percentage changes of nominal GDP for both Denmark and UK from the baseline levels. Finally, to better understand the GDP effects in connection with the trade policy shocks assumed in the two scenarios, contributions of individual policy shocks to the combined GDP effects are computed separately for each of the two scenarios.

In the WTO scenario with both increasing MFN tariff and NTBs, Denmark's GDP would decrease by less than two-third of a percentage point from the baseline, as compared to the much larger loss of GDP for the UK at 4.8 percent. As reported in Table 10 the much smaller GDP reduction effect for Denmark can be decomposed into four components:

- 1.1 percent reduction to Denmark's GDP, due to rising trade costs by the UK (i.e. MFN tariffs and NTBs) against exports from Denmark, as these extra trade costs reduce Denmark's exports;
- 0.35 percent increase in Denmark's GDP, due to rising trade costs by the EU (including Denmark) on UK exports as these trade costs reduce UK's exports to Denmark and lead to higher domestic outputs in Denmark;
- 0.06 percent increase in Denmark's GDP, due to rising trade costs by UK on exports originated from the EU's FTA partner countries, as these trade costs reduce the partner countries' exports to the UK, thereby increasing the UK's domestic production and its imports from elsewhere (including those from EU member states);
- and similarly 0.01 percent increase in Denmark's GDP, due to rising trade costs by the EU's FTA partner countries against exports from the UK, as these trade costs lowers exports from the UK to the FTA partner countries, thereby indirectly increasing exports from EU member states to their FTA partner countries.

[11] It is worth noting that with rising bilateral trade barriers/costs, aggregated export price indices for exports from both the EU (including Denmark) and the UK would decrease under both the WTO and the FTA scenarios. For instance, Denmark's export price indices by products would decrease by between 0.3 and 0.6 percent under the FTA scenario, and by between 0.4-0.9 percent under the WTO scenario.

Overall, the last two effects appear to be rather insignificant,[12] while the negative effects due to rising UK trade costs are expected to be partially offset by the positive GDP effect from rising EU trade costs against UK exports.

Table 10. Changes in GDP from baseline, % from baseline

		Effects due to			
	Total effects	Rising UK trade costs on EU exports	Rising EU trade costs on UK exports	Rising UK trade costs on exports from EU FTA countries	Rising trade costs by EU FTA countries on UK exports
			WTO (MFN+NTB)		
DK	-0.64 (-0.15)	-1.09	0.35	0.06	0.01
UK	-4.82 (-1.08)	1.24	-6.05	0.43	-0.54
			FTA		
DK	-0.44 (-0.09)	-0.76	0.22	0.08	0.01
UK	-3.41 (-0.61)	1.04	-4.25	0.33	-0.52

Note: except numbers in parentheses which are defined in the GTAP model as percentage changes in quantity of GDP, all other numbers are percentage changes in the values of GDP.
Source: own simulation results with the GTAP model and database.

Similarly, the much larger negative GDP effect on the UK can be decomposed into contributions from the same four policy shocks, as reported in Table 10. In particular, rising trade costs by the EU alone would reduce UK GDP by over 6 percent, which is expected to be partially offset by a 1.2 percent increase due to rising trade costs by the UK itself. Additionally, rising trade costs by the UK against exports from EU FTA partner countries also increase UK GDP by 0.43 percent; however, a slightly large decrease in the UK GDP is expected from rising trade costs by the EU FTA partner countries against exports from the UK.

Under the FTA scenario, reductions of GDP in Denmark and the UK are expected to be at 0.44 and 3.4 percent respectively, smaller than those simulated under the WTO scenario. In the case of Denmark, this aggregated GDP effect can again be decomposed by the four different policy shocks,

[12] If instead the UK is included in the FTAs negotiated by the EU with third countries, these small positive GDP effects (at about 0.07 percent) would disappear, resulting in slightly smaller GDP gains for Denmark.

with rising trade costs by the UK reducing Denmark's GDP by about three-fourth of a percentage point and other policy shocks provide offsetting GDP effects. For the UK, rising trade costs by the EU and the EU FTA partner countries would reduce UK's GDP by nearly 4.8 percent, whereas rising trade costs by the UK against the EU and its FTA partner countries provide smaller positive effects.

In summary, as measured by changes in GDP values from the baseline, under the WTO scenario it appears that Denmark would suffer a loss of GDP at around two-third of a percentage point whereas the loss of GDP for the UK to be much larger at nearly 5 percent. The major driving forces behind the negative GDP effects for Denmark (UK) are the rising trade barriers by the UK (Denmark). For each of the two countries, its own rising trade barriers would moderate but would not be enough to offset these GDP losses. Additionally, while rising trade barriers between the UK and the EU's FTA partner countries would increase Denmark's GDP marginally, rising bilateral trade barriers by the UK and by the EU's FTA partner countries would generate opposite GDP effects for the UK. In the FTA scenario, similar patterns are observed, albeit with smaller scale.[13]

It is worth noting that the above reported percentage changes in nominal GDP reflect both changes in the levels of gross domestic outputs and in the levels of the associated prices. When the price levels are taken out, real GDP would decrease at a much smaller scale for both countries under the two scenarios. For instance, under the WTO scenario, real GDP in Denmark would only shrink by 0.15 percent and that in the UK would decrease by 1.08 percent (see numbers in parentheses in Table 10). A simple explanation for the much smaller real GDP effect is that rising trade costs due to Brexit drives up domestic prices of imported goods.

5. Conclusion and discussions

With the UK referendum paving the way for the UK to exit the EU, there has been pressing demand on understanding its potential impacts. In the case of Denmark, UK has been a very important trade partner in general and a particularly important export destination for a number of agricultural and food products. This study therefore offers a set of simulation results obtained from a CGE modeling exercise under two specific Brexit scenarios to meet this need. The scenarios considered include a "normal" FTA between the UK and EU and a WTO scenario in which the two sides have to treat each other on ordinary WTO MFN terms. What differentiates the current study from existing studies rests

[13] As the baseline assumes several FTAs likely to be agreed or implemented in 2021, there are some further flexibilities for remaining EU members including Denmark to redirect trade away from UK. Therefore, in the absence of these assumed FTAs, it is possible that the negative trade and GDP effects arising from Brexit would be larger.

on three points. First, the current study has an explicit focus on the impact on Danish agricultural sectors, particularly in relation to processed foods, pork products, and milk and dairy products. This is a key difference from most of the existing studies that are focused on the macroeconomic effects of Brexit. Second, we consider not only the rising tariff barriers but also rising NTBs across different sectors, particularly in the WTO scenario where the latter is likely to rise substantially. And indeed these NTBs have very significant effects on the results. Third, the two scenarios examined in the current study not only consider rising total trade costs between the EU (including Denmark) and the UK, they also take into consideration potential complications arising from the need for the UK to reconfigure its trade arrangement with the EU's FTA partner countries. Towards this end, we assume that the UK will have to exit these FTA arrangements. Such an assumption has important implications for both the UK and EU (including Denmark) in connections with their ability to redirect bilateral trade flows.

Simulation results obtained from the modeling exercises of the current study are of the "medium-run" nature, as all domestic and international markets are assumed to be in equilibrium following the assumed trade policy shocks. As compared to a baseline for the year 2021, simulation results suggest that bilateral exports from Denmark to the UK would shrink significantly under the WTO scenario, particularly for key export products such as processed foods, pork products, and dairy. Total Danish food and agricultural exports to the UK would fall by as much as 80 percent under the WTO scenario and by about 48 percent under the FTA scenario, under the assumed increases in bilateral tariffs and NTBs between the EU and UK as well as rising tariffs between the UK and third countries with which the EU has FTA arrangements. On the flip side, the UK's agri-food exports are also expected to drop significantly.

Despite the very large simulated decrease in bilateral exports from Denmark to the UK, results from model simulations also suggest that reductions of total Danish agri-food exports would be quite limited. For pork, dairy, processed foods, the simulated reductions in exports are between 2.7 and 4.1 percent only. This seemingly surprising result – given the UK's significant share in total Danish exports in these sectors – is due to the possibilities for Danish exports to be redirected within the EU and to third countries particularly those countries which are partners to the various preferential trade agreements of the EU assumed in the baseline. It should however be noted that redirected Danish exports to other markets would be accompanied by slightly reduced export prices.

As total agri-food exports from Denmark only suffer small losses due to the assumed Brexit scenarios, simulation results from the current study also suggest that reductions in domestic production of key export products in Denmark would be quite small. For instance, for processed foods, pork, and dairy, outputs would be 2.5, 2.2, and 1.1 percent lower than their respectively baseline levels. In connections with changes in domestic outputs, sectoral reallocations of production factors such as labor and capital are also expected in the "medium run" horizon assumed in the model. As an indication of possible short run sectoral unemployment, the processed food, pork and dairy sectors' employment of skilled and unskilled labor would shrink by 1-2.6 percent under the WTO scenario; under the FTA scenario, simulated negative employment effects are smaller for the three sectors, in the range of 0.2-1.5 percent.

At the macro level, nominal GDP for both Denmark and the UK are expected to decrease relative to the baseline; however, losses to Danish GDP are expected to be much smaller at about 0.64 percent under the WTO scenario and at 0.44 under the FTA scenario, as compared to 4.8 and 3.4 percent losses for the UK under the two scenarios respectively. Losses of real GDP are smaller for both Denmark and the UK, with the percentage losses for Denmark being smaller than that for the UK. These relative differences in GDP losses are indications of the asymmetric nature of the trade policy implications of Brexit: while the assumed increases in trade costs are the same for both the UK and EU, in effect the UK would have to face rising trade costs from all 27 remaining member states of the EU, a much larger export destination accounting for a large portion of its exports, as well as rising trade barriers from the EU's FTA partner countries; for Denmark and other EU member states, rising trade costs only extend to the UK markets. Therefore, losses to GDP associated with reduced trade volumes would be understandably small for the remaining EU member states such as Denmark, not least because the EU single market and preferential accesses to the market of EU's FTA partner countries provide ample flexibilities to redirect trade flows.

Taken together, the results reported in this study are in line with the majority of existing studies regarding the harmful effects of Brexit to bilateral trade flows with the UK as well as the negative GDP effects for the UK and its trading partners within the EU. As an important destination market for Denmark, losing the UK as part of the EU single market would damage the export prospects of several key agri-food products originated from Denmark; however, such negative effects at the bilateral level can be partially avoided by redirecting trade within the EU market and with other countries. Following this logic and the numerical results, it is possible that further trade liberalization

either through the multilateral process or through the EU's various bilateral initiatives aiming at further reducing trade barriers elsewhere will bring new trade opportunities for Danish products. With regard to the bilateral trade-relationship between Denmark and UK in the future, it is quite apparent that a WTO MFN relationship is not desirable for either side, and that an FTA between the UK and EU, while representing several steps back from *status quo*, would be much preferable to the WTO MFN option.

Several caveats of the study also deserve some discussion. First, the simulation results are dictated by both the modeling structure and the assumptions regarding the Brexit scenarios including the magnitude of rising import tariffs and NTBs. In the latter case, uncertainties associated with the magnitude of estimated NTBs adopted from the limited current academic literature may be a cause of concern. Therefore, cautions need to be exercised when scrutinizing the simulation results resting on such assumptions. Second, out of the many possible Brexit scenarios, the current study – as in the case of a few other existing studies – only considers some indicative benchmarking scenarios (i.e. the WTO and FTA scenarios in the current study). The actual arrangements to be agreed by the UK and EU and possibly with third countries are of course not known at this time. Therefore, the presented results in the current study should not be treated as "predictions" and should only be understood within the specific assumptions and context of the two scenarios. Third, the scope of the current study is to model only the impacts of two alternative Brexit trade arrangement scenarios and the results are solely driven by the assumed changes in trade policies. Therefore, other considerations such as those surveyed in Kierzenkowski et al. (2016) are not taken into account. In relation to this point, for the agricultural sectors, a notable omission is about the implications of Brexit on the Common Agricultural Policy (CAP) of the EU and how possible changes in the CAP due to Brexit may influence agri-food trade. As a net contributor to the EU budget and the CAP budget, Matthews (2016) points out several channels through the Brexit can influence the CAP and agri-food trade, including future market orientations of the CAP, the size of the EU budget, regulatory environment in the EU, and EU's trade relationship with third countries. A quantitative study by Boulanger and Philippidis (2015) finds that the UK can actually gain from withdrawal from the EU budget but administrative, procedural and trade facilitation costs due to exit from the EU's single market would lead to overall welfare losses for the UK. Moreover, a full withdrawal from the EU would lead to welfare losses for both the EU and for Britain. It is however not clear from existing literature how the CAP dimension would impact Denmark. This therefore can be an interesting issue to investigate in a further study.

References

AICHELE, R. & FELBERMAYR, G. 2015. Costs and benefits of a United Kingdom exit from the European Union. *Guetersloh: Bertelsmann Stiftung*.

BOOTH, S., HOWARTH, C., PERSSON, M., RUPAREL, R. & SWIDLICKI, P. 2015. What if…? The Consequences, Challenges & Opportunities Facing Britain Outside EU. London: www.openeurope.org.uk.

BOULANGER, P. & PHILIPPIDIS, G. 2015. The End of a Romance? A Note on the Quantitative Impacts of a 'Brexit' from the EU. *Journal of Agricultural Economics,* 66**,** 832-842.

CARRÈRE, C. & DE MELO, J. 2006. Are different rules of origin equally costly? Estimates from NAFTA. *In:* CADOT, O., ESTEVADEORDAL, A., SUWA-EISENMANN, A. & VERDIER, T. (eds.) *The Origin of Goods: Rules of Origin in Regional Trade Agreements.* Oxford Scholarship Online.

DHINGRA, S., OTTAVIANO, G. I., SAMPSON, T. & REENEN, J. V. 2016. The consequences of Brexit for UK trade and living standards. *Centre for Economic Performance, London School of Economics and Political Science (LSE)*.

EGGER, P., FRANCOIS, J., MANCHIN, M. & NELSON, D. 2015. Non-tariff barriers, integration and the transatlantic economy. *Economic Policy,* 30**,** 539-584.

EMERSON, M., BUSSE, M., SALVO, M. D., GROS, D. & PELKMANS, J. 2017. An Assessment of the Economic Impact of Brexit on the EU27. DIRECTORATE GENERAL FOR INTERNAL POLICIES: Centre for European Policy Studies (CEPS), Brussels.

FOURÉ, J., BÉNASSY-QUÉRÉ, A. & FONTAGNÉ, L. 2012. The Great Shift: Macroeconomic projections for the world economy at the 2050 horizon. Paris: CEPII.

GUIMBARD, H., JEAN, S., MIMOUNI, M. & PICHOT, X. 2012. MAcMap-HS6 2007, an exhaustive and consistent measure of applied protection in 2007. *International Economics,* 130**,** 99-121.

HERTEL, T. W. & TSIGAS, M. E. 1997. Structure of GTAP. *Global Trade Analysis: modeling and applications.* Cambridge University Press.

IRWIN, G. 2015. BREXIT: the Impact on the UK and the EU. . Global Council, London.

KIERZENKOWSKI, R., PAIN, N., RUSTICELLI, E. & ZWART, S. 2016. The economic consequences of Brexit: a taxing decision. *OECD Economic Policy Papers***,** 1.

MATTHEWS, A. 2016. The Potential Implications of a Brexit for Future EU Agri-food Policies. *EuroChoices,* 15**,** 17-23.

MÉJEAN, I. & SCHWELLNUS, C. 2009. Price convergence in the European Union: Within firms or composition of firms? *Journal of International Economics,* 78**,** 1-10.

PWC 2016. Leaving the EU: Implications for the UK economy. PricewaterhouseCoopers (PwC) report commissioned by The Confederation of British Industry (CBI).

ROJAS-ROMAGOSA, H. 2016. Trade effects of Brexit for the Netherlands. CPB, Netherlands Bureau for Economic Policy Analysis.

TREASURY, H. M. 2016. HM Treasury analysis: the long-term economic impact of EU membership and the alternatives. *Parliament by the Chancellor of the Exchequer by command of Her Majesty, April*.

VAN BERKUM, S., JONGENEEL, R., VROLIJK, H., VAN LEEUWEN, M. & JAGER, J. 2016. Implications of a UK exit from the EU for British agriculture. LEI Wageningen UR.

Appendix Table 1. Bilateral exports/imports of selected products from/to Denmark in 2011-2013

DK exports in mn DKK to									
	2011			2012			2013		
	UK	EU	World	UK	EU	World	UK	EU	World
Processed Food	3,968	7,859	34,107	3,897	8,119	35,223	4,545	8,993	38,652
BeverageTabacco	224	1,330	5,740	297	1,188	6,493	516	1,384	7,230
Bovinemeats	181	527	5,105	121	530	5,040	122	616	5,075
PorkPoultry	5,746	3,640	28,305	4,916	3,846	28,486	5,050	3,673	28,208
OtherAnimalProd	39	1,197	9,036	83	1,351	10,659	43	1,248	11,920
VegeOil	74	1,415	3,091	141	1,315	3,125	71	1,293	2,980
MilkDairy	1,832	3,295	14,802	1,767	3,428	14,751	1,292	3,163	14,991
All	53,878	123,631	520,206	52,825	124,664	527,205	46,811	123,084	528,735
All AgriFood	12,709	22,554	114,599	12,152	22,990	117,685	12,948	23,538	123,577
DK imports in mn DKK from									
	2011			2012			2013		
	UK	EU	World	UK	EU	World	UK	EU	World
Processed Food	995	5,023	26,036	869	5,253	26,690	1,299	5,952	28,325
BeverageTabacco	551	940	6,880	586	914	6,591	860	1,222	7,522
Bovinemeats	204	261	3,906	100	290	3,972	169	275	4,347
PorkPoultry	207	699	6,501	181	704	7,836	206	730	7,650
OtherAnimalProd	71	1,156	2,695	74	917	2,885	54	1,547	3,636
VegeOil	58	442	6,347	32	581	7,427	7	630	8,191
MilkDairy	152	1,061	4,368	150	968	3,750	142	1,060	4,645
All	27,225	119,921	488,942	22,991	123,229	492,111	25,772	122,238	494,527
All AgriFood	2,595	12,269	71,804	2,512	12,472	75,250	3,108	13,841	80,493

Source: compiled from the GTAP database version 9. Trade data from the GTAP database are originally sourced from the UN COMTRADE database. Product classifications listed in column 1 are based on the GTAP classification (see www.gtap.org) Official annual exchange rates are used for converting the GTAP data in USD into DKK.

Appendix Table 2a. List of sectors

	Aggregated sectors	Disaggregated GTAP **sectors** included
1	Pdr	Paddy rice
2	Wht	Wheat
3	Gro	Cereal grains nec
4	v_f	Vegetables, fruit, nuts
5	Osd	Oil seeds
6	c_b	Sugar cane, sugar beet
7	Pfb	Plant-based fibers
8	Ocr	Crops nec
9	bovineanimal	Bovine cattle, sheep and goats, horses
10	Oap	Animal products nec
11	rawmilk	Raw milk
12	Wool	Wool, silk-worm cocoons
13	Extraction	Forestry, Coal, Oil, Gas, Minerals nec
14	Fish	Fishing
15	bovinemeats	Bovine meat products
16	porkpoultry	Meat products nec
17	Vol	Vegetable oils and fats
18	milkdairy	Dairy products
19	Pcr	Processed rice
20	Sugar	Sugar
21	Ofd	Food products nec
22	b_t	Beverages and tobacco products
23	Textwapp	Textiles, Wearing apparel
24	LightMnfc	Leather products, Wood products, Paper products, publishing, Metal products, Motor vehicles and parts, Transport equipment nec, Manufactures nec
25	HeavyMnfc	Petroleum, coal products, Chemical, rubber, plastic products, Mineral products nec, Ferrous metals, Metals nec, Electronic equipment, Machinery and equipment nec
26	Util_Cons	Electricity, Gas manufacture, distribution, Water, Construction
27	TransComm	Trade, Transport nec, Water transport, Air transport, Communication
28	OthServices	Financial services nec, Insurance, Business services nec, Recreational and other services, Public Administration (Defense, Education, Health), Dwellings

Source: own aggregation of sectors in the GTAP database.

Appendix Table 2b. List of aggregated countries/regions

Aggregation of region	Countries/regions included
Australia	Australia
NZL	New Zealand
RestofWorld	Rest of Oceania
China	China, Hong Kong
Japan	Japan
Korea	South Korea
RoEAsia	Mongolia, Taiwan, Rest of East Asia
SEAsia	Brunei Darussalam, Cambodia, Laos, Malaysia, Singapore, Rest of Southeast Asia
IdnPhl	Indonesia, Philippines
Thailand	Thailand
Vietnam	Vietnam
RoSAsia	Bangladesh, Nepal, Pakistan, Sri Lanka, Rest of South Asia
India	India
Canada	Canada
USA	USA
Mexico	Mexico
RofNAme	Rest of North America
Argentina	Argentina
LatinAmer	Bolivia, Chile, Colombia, Ecuador, Paraguay, Peru, Uruguay, Venezuela, Rest of South America, Costa Rica, Guatemala, Honduras, Nicaragua, Panama, El Salvador, Rest of Central America, Dominican Republic, Jamaica, Puerto Rico, Trinidad and Tobago, Caribbean
Brazil	Brazil
RofEU	Austria, Belgium, Cyprus, Czech Republic, Estonia, Finland, Greece, Hungary, Latvia, Lithuania, Luxembourg, Malta, Portugal, Slovakia, Slovenia, Sweden, Bulgaria, Croatia, Romania
Denmark	Denmark
France	France
Germany	Germany
Ireland	Ireland
Italy	Italy
Netherlands	Netherlands
Poland	Poland
Spain	Spain
UK	Great Britain
Switzerland	Switzerland
Norway	Norway

RestofWorld	Rest of EFTA, Albania, Belarus, Rest of Eastern Europe, Rest of Europe, Kazakhstan, Kyrgyzstan, Rest of Former Soviet Union, Armenia, Azerbaijan, Georgia, Rest of the World
Russia	Russia
Ukraine	Ukraine
MENA	Bahrain, Iran, Israel, Jordan, Kuwait, Oman, Qatar, Saudi Arabia, United Arab Emirates, Rest of Western Asia, Morocco, Tunisia, Rest of North Africa
Turkey	Turkey
Egypt	Egypt
SSA	Benin, Burkina Faso, Cameroon, Cote dIvoire, Ghana, Guinea, Nigeria, Senegal, Togo, Rest of Western Africa, Central Africa, South Central Africa, Ethiopia, Kenya, Madagascar, Malawi, Mauritius, Mozambique, Rwanda, Tanzania, Uganda, Zambia, Zimbabwe, Rest of Eastern Africa, Botswana, Namibia, Rest of South African Customs Union
SAfrica	South Africa

Source: own aggregation of countries/regions in the GTAP database.

Appendix Table 3. Changes in bilateral pork exports from Denmark, from baseline levels

	% changes in bilateral exports			changes in bilateral exports (mn USD)		
	WTO (MFN only)	WTO (MFN+NTB)	FTA	WTO (MFN only)	WTO (MFN+NTB)	FTA
Australia	2.1	7.4	5.3	-5.1	1.8	-0.9
NZL	2.9	6	5.1	-5.6	-5.4	-5.5
China	1.7	7.8	4.8	-0.2	15.0	7.5
Japan	0.6	1.8	1	3.0	50.6	13.8
Korea	1.5	3.6	2.3	-1.1	2.7	0.2
RoEAsia	2.2	8.5	5.7	0.0	0.0	0.0
Vietnam	3.3	8	5.5	0.1	0.4	0.3
Thailand	0.4	3.8	1.3	-0.1	0.3	0.0
IdnPhl	3.5	8	5.7	0.4	1.7	1.0
SEAsia	0.4	7	3.3	-0.2	1.3	0.4
11 India	1.3	3.6	1.4	0.0	0.1	0.0
RoSAsia	2.6	6.1	3.2	0.0	0.0	0.0
Canada	1.8	8	5.3	-0.1	0.3	0.1
USA	1.8	7.6	5.1	-8.2	-2.2	-4.8
Mexico	2	8.1	5.6	-0.1	0.2	0.1
RofNAme	1.3	4.4	2.8	-0.1	0.4	0.1
Argentia	0.3	7.7	3.5	0.1	0.8	0.4
Brazil	2.8	6.4	3.8	0.0	0.0	0.0
LatinAmer	1.9	8.7	5.1	0.0	1.3	0.6
Denmark	3.1	3.9	2.9	0.0	0.0	0.0
France	2.4	3.3	2	2.3	2.5	2.0
Germany	2	3.4	1.9	22.1	27.2	20.6
Ireland	28	37.2	27.9	7.5	9.8	7.4
Italy	1.1	2.3	1.1	2.3	3.6	2.0
Netherlands	0.2	4.2	1.5	0.0	0.5	0.2
Poland	5.2	5.9	4.5	15.1	15.9	12.0
Spain	2	3.4	1.8	0.8	1.0	0.7
RofEU	1.3	1.4	0.6	9.3	8.0	5.2
UK	-46.7	-94.3	-51	-254.9	-523.5	-280.0
Switzerland	1.2	4.9	2.6	0.0	0.1	0.0
Norway	1.6	4.2	2.4	0.3	2.1	0.8
Russia	1.3	6.2	3.8	-0.6	8.3	3.9
Ukraine	2	5.3	3.1	0.1	0.2	0.1
Turkey	1.2	6.2	3.6	0.0	0.0	0.0
Egypt	-0.6	6.7	2.6	0.0	0.3	0.1
MENA	0.6	6.6	3.4	0.2	1.6	0.8
SAfrica	5.2	11.3	7.9	0.6	1.3	0.9
SSA	1.4	6.3	3.6	0.0	0.5	0.2
RestofWorld	1.8	6.3	3.9	0.0	2.1	0.9
total	-1.6	-2.7	-1.3	-212.4	-369.7	-208.6

Source: simulation results.

Appendix Table 4. Changes in total exports by exporting countries, % from baseline

	WTO (MFN only)	WTO (MFN+NTB)	FTA
Australia	-0.07	-0.48	-0.34
NZL	-0.1	-0.06	-0.11
China	-0.06	-0.32	-0.23
Japan	-0.12	-0.64	-0.45
Korea	-0.07	-0.07	-0.07
RoEAsia	0	0.07	0.06
Vietnam	0.08	0.05	0.09
Thailand	-0.06	0.08	0.09
IdnPhl	-0.08	-0.25	-0.19
SEAsia	0.05	0.27	0.21
India	0.05	0.29	0.25
RoSAsia	-0.01	-0.08	-0.04
Canada	-0.08	-0.11	-0.09
USA	-0.1	-0.5	-0.36
Mexico	-0.04	-0.19	-0.14
RofNAme	0.08	0.34	0.28
Argentia	-0.11	-0.77	-0.46
Brazil	-0.08	-1.03	-0.61
LatinAmer	-0.01	-0.12	-0.09
Denmark	-0.06	-0.43	-0.29
France	-0.13	-0.57	-0.45
Germany	-0.07	-0.48	-0.36
Ireland	-0.44	-1.77	-1.26
Italy	-0.08	-0.49	-0.35
Netherlands	-0.09	-0.76	-0.56
Poland	-0.11	-0.5	-0.38
Spain	-0.07	-0.22	-0.19
RofEU	-0.03	-0.22	-0.16
UK	-3.12	-9.33	-7.23
Switzerland	0.01	0.1	0.1
Norway	0.02	0.14	0.1
Russia	-0.03	-0.2	-0.14
Ukraine	-0.03	0.01	0.03
Turkey	-0.01	0.14	0.13
Egypt	-0.11	-0.42	-0.3
MENA	0	-0.02	-0.02
SAfrica	-0.37	-0.32	-0.32
SSA	0.03	0.03	0.01
RestofWorld	0.01	0	0

Source: simulation results. Changes exceeding +/-0.25% are highlighted.